Impacts of PPCPs on the Environment & Solutions

How do PPCPs affect the environment?

The occurrence of PPCPs in groundwater and surface water impacts the water quality and can cause a series of negative effects on the environment and both plants and animals can be impacted. For example, hormones are highly potent endocrine-disrupting chemicals (EDCs) which, even at levels as low as nanograms per liter (10^{-9} g/L or ppt), can adversely affect the reproductive biology of aquatic species. Researchers across the world have seen feminization of male fish due to the presence of estrogen and similar compounds in water. Also, when fish were exposed to antidepressants, the fish had a delayed response to predators (making them easier to catch) and also male fish displayed less interest in mating.

Also as a result of our use of PPCPs, residuals of certain PPCPs remaining in sewage treatment plants' treated wastewater effluent can cause a reduction in microbial and ecosystem diversity and antibacterial resistance in the bacteria downstream of the effluent discharge point.

In addition, liquid manure is often spread on farm land for its nutrient value. With the increase in extreme weather, treated wastewater effluent may need to be used for crop irrigation in the future, especially in drought conditions. But what happens to the PPCPs and natural hormones that remain in the wastewater or liquid manure? Some of the PPCPs and natural hormones will run off the land into streams during rain events while another portion might be taken up into plants in the fields.

ISTC researchers conducted an initial study on two plants to see how much of the PPCPs were taken up and into which plant parts:

- **Tomatoes** – most PPCPs were concentrated in the roots of the plants; some were found in the leaves and stems; and a few at low concentrations were found in the tomato fruit, which indicates the potential for unintended human exposure to PPCPs though food.
- **Lettuce** – similar results to tomatoes with most PPCPs concentrating in the roots; and some in the leafy part; but because the leafy part is consumed, lettuce poses a higher potential risk for unintended human exposure to PPCPs.

The risk of exposure to PPCPs through food is highly dependent upon the type of PPCP, the plant, and what part of the plant is being consumed.

PPCPs uptake experiment with tomatoes and lettuce via hydroponics

What are some solutions to these issues?

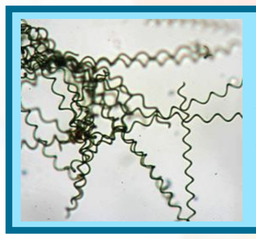
While tackling the PPCPs issue may look difficult, there are solutions being tested to reduce the environmental impacts of PPCPs.

ILLINOIS
Illinois Sustainable Technology Center
PRAIRIE RESEARCH INSTITUTE

ISTC researchers have shown that increased temperature and residence time of liquid manure in the large animal feeding operations' treatment lagoons or tanks can significantly reduce the presence of PPCPs in the liquid manure due to biological breakdown of those chemicals. In addition, ISTC researchers developed a pilot scale hormone-removal system for liquid manure while maintaining the nutrient value for crop lands.

Pilot scale hormone-removal system for liquid manure

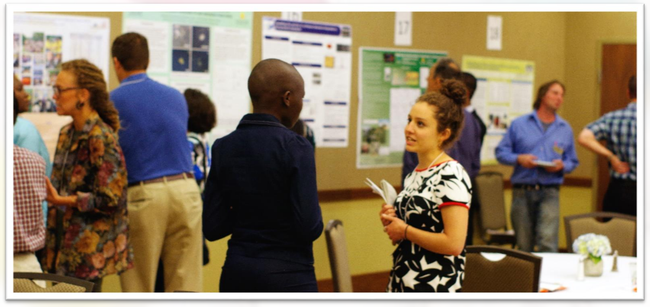
Another study used raw wastewater to grow algae and then converted the algae to a bio-oil (a waste-to-energy process). This process also destroyed or deactivated any PPCPs in the wastewater that had been taken up by the algae.



Example of *Spirulina* algae under magnification

Education is also a powerful tool for reducing PPCPs in the environment. ISTC has hosted a teacher workshop on these concepts based on curriculum developed by the Illinois-Indiana Sea Grant that provides hands-on activities for teachers to do with their classes. ISTC created a video for health care and veterinary professionals and students to inform them of these issues and how they can educate patients on the best disposal methods for PPCPs. Two panels were created on PPCPs issues for the Prairie Research Institute's traveling science center that goes to Illinois schools to educated students on environmental topics.

Traveling Science Center



2017 Emerging Contaminants in the Aquatic Environment Conference

Furthermore, ISTC has hosted several conferences on emerging contaminants and PPCPs in the environment in order for researchers to share their knowledge and collaborate to develop solutions.